Annual Report Instructions for Multi-year Cooperative Projects

This report should be more detailed than the six-month report, but contains much of the same information. Both the academic and the operational forecasting partners should be involved with completing the report. The Outreach Program will forward a copy of the report to the region's SSD Chief who will then send an endorsement of the project for another year or a recommendation that the project be terminated, depending on whether reasonable progress is being made. This report also provides a plan for the next year's work and a budget request. If your budget is the same as in the original proposal, write a statement to that effect and do not attach a new budget page. If you need to revise your budget, attach a new form and justify the changes in costs in the body of the report. Please note that increases in funding are subject to COMET Program approval and availability of funds. NOTE: Your next year of funding will not be authorized until the proposal has been reviewed and approved and the contract modified. As this can take one month or more, you should plan on submitting your report well in advance of the budget end date.

Please send a hard copy and/or e-mail the completed report and budget page (if one is required) to Bonnie Slagel.

University: University of Oklahoma

Name of University Researcher Preparing Report: John Cortinas Jr., Ph.D.

NWS/AFWA/Navy Office: NCEP/HPC and NCEP/SPC

Name of NWS/AFWA/Navy Researcher Preparing Report: Keith Brill

Partners or Cooperative Project: Cooperative UCAR Award No.: S00-19128

Date: 05/01/01

SECTION 1: PROJECT OBJECTIVES AND ACCOMPLISHMENTS

1.1 *(To be completed by academic and forecaster partners)* Summarize the overall project objective(s) and the responsibilities of the various project participants. Describe the research/development activities and accomplishments carried out to date. These accomplishments may relate specifically to the original project objectives, or they may be ones that arose during the course of the project (i.e., development of an innovative method for accomplishing the objective or insight into a related problem). Highlight any major changes to the scope of work. If the project involved separate research topics, please list each separately.

See attached

SECTION 2: SUMMARY OF RESEARCH AND EDUCATIONAL EXCHANGES

2.1 *(To be completed by academic and forecaster partners)* Summarize other exchanges between your two organizations. These may include seminars or training workshops conducted by either the university or NWS/AFWA/Navy, participation of operational forecasters in university classes, joint preparation of publications, participation of students at the forecast

office, etc. These do not have to be functions specifically funded by the COMET Outreach Program, but may include interactions undertaken in the spirit of improving relations between the academic and operational forecasting communities. See attached

SECTION 3: PRESENTATIONS AND PUBLICATIONS

3.1 *(To be completed by academic and forecaster partners)* Please provide complete citations using the AMS bibliographic format for each thesis, dissertation, publication or presentation prepared as part of this project. See attached

SECTION 4: SUMMARY OF BENEFITS AND PROBLEMS ENCOUNTERED

4.1 *(To be completed by academic partner)* Please list the benefits to the University resulting from the collaboration (new understanding of forecasting problems, exposure of students to operational forecasting, access to new observing systems, changes in course offerings, use of NWS/AFWA/Navy personnel as resource, etc.). Identify any major problems encountered and describe their resolution. See attached

4.2 *(To be completed by forecaster partner)* Please list the benefits to the NWS/AFWA/Navy office resulting thus far from the collaboration (promising new forecasting technique, heightened interest in research in the office, better understanding of new observing systems, potential new hires, use of university personnel as resource, etc.). Please be as specific as possible, particularly in regard to any improvements in forecasting resulting from the COMET project (see examples). Identify any major problems encountered and describe their resolution. See attached

SECTION 5: PLAN OF WORK FOR THE NEXT YEAR

5.1 *(To be completed by academic and forecaster partners)* Describe what tasks remain from the original scope of work and the plan for accomplishing them. Please summarize the breakdown of work between the university participants and the operational forecasters. See attached

SECTION 6: FUNDING REQUEST

(To be completed by academic and forecaster partners) If your budget for the next year is different from what was originally proposed, please attach a revised budget form.

SECTION 1: PROJECT OBJECTIVES AND ACCOMPLISHMENTS

1.1 *(To be completed by academic and forecaster partners)* Summarize the overall project objective(s) and the responsibilities of the various project participants. Describe the research/development activities and accomplishments carried out to date. These accomplishments may relate specifically to the original project objectives, or they may be ones that arose during the course of the project (i.e., development of an innovative method for accomplishing the objective or insight into a related problem). Highlight any major changes to the scope of the work. If the project involved separate research topics, please list each separately.

The objectives for this project are:

1) Develop a high-quality (in the statistical sense) technique for making probabilistic forecasts of precipitation type with numerical model output and an ensemble of precipitation-type algorithms from one or more models.

2) Determine if the quality of several precipitation-type algorithms can be improved by modifications based on observations.

3) Determine the quality of six precipitation-type algorithms using observations and mesoscale model output.

4) Identify efficient methods of displaying probabilistic forecast output of precipitation type for forecasters at the HPC and the SPC.

5) Work with EMC to incorporate the algorithms into their model output processing routines in order to distribute the precipitation-type output to all NWS offices.

6) Familiarize forecasters with the meteorological processes that are associated with the formation of various precipitation types.

In order to accomplish these objectives, project responsibilities have been divided among the three principal investigators, John Cortinas, Keith Brill, and Michael Baldwin. John Cortinas and Mike Baldwin developed the computer code for the precipitation-type algorithms, and Keith Brill was responsible for implementing the forecast system at the HPC. All three investigators have worked together on verification tasks, monitoring daily output, providing input for the project web site, and providing information to HPC and SPC forecasters about the algorithms. Operational forecaster involvement was coordinated by Peter Manousos, SOO-HPC, and Jon Racy, Mesoscale Forecaster-SPC. Additionally, 24 HPC and SPC forecasters provided extremely valuable evaluations during the first year of the project.

Since June 1, 2000, resources for the project have been devoted to: (1) creating a procedure to run the precipitation-type algorithms and distribute the numerical output to HPC and SPC forecasters, (2) developing an evaluation form for forecasters to submit,

and (3) creating a website for the project. Currently six algorithms are being run and the output data are being distributed from a workstation at the HPC. The data are distributed in a format that is easy to view on HPC and SPC workstations and includes numerous plots that show the hourly output from each algorithm as well as ensemble products that show the most likely type of precipitation and a risk assessment (e.g., low, medium, and high) of each precipitation type.

A website for this project (http://www.spc.noaa.gov/exper/ptax) has been created by a university research assistant and is being hosted by the SPC. It provides forecasters with educational material about the algorithms as well as information about the COMET project, an online archive that provides easy access to project data, a web-based evaluation form for forecasters, access to project status reports, and ongoing verification statistics. Forecaster comments indicate that the web-based form is the preferred method for submitting comments and reviewing project materials.

Forecaster evaluation forms were created with the assistance of the SOO at the HPC and a forecaster from the SPC to provide forecaster feedback on the usefulness of the algorithm output, the format of the products, and the forecaster's perceived accuracy of the products. Between October 2000 and March 2001, 138 (66 from SPC forecasters and 72 from HPC forecasters) evaluations were submitted, with over 92% of those that evaluated the usefulness of the output stating that it had been useful (27%), very useful (27%), or extremely useful (39%) in creating the current NWS product. The evaluations show that HPC forecasters used the algorithm output most often for the first 12-h Winter Weather Forecast and the 24-h Day Two Winter Weather Forecast. SPC forecasters used the output for their Mesoscale Discussion product. The evaluations also indicate that forecasters used the algorithm output based on the Eta solution more often than output from the RUC. Most (> 95%) of the forecaster evaluations that commented on the presentation format of the output indicated that it was presented in a useful way.

While most project tasks in year one have focused on setting up a real-time system for forecaster evaluation, some verification statistics have been computed daily and are available on the daily archive page of the project's web page, <www.spc.noaa.gov/exper/ptax>. These statistics are part of the end-to-end system proposed in this project. In addition to these online statistics, a preliminary evaluation of the most probable precipitation-type forecast (MPPTF) at 630 stations (using Eta model output) has been accomplished for the period 1 November 2000 - 31 March 2001 (Table 1). This analysis was performed to determine the quality of the consensus forecast and to identify possible problems with the system. For example, the MPPTF probability of detection for each of the weather types is lower than that calculated for each of the individual algorithms in a different study that used rawinsonde data as the verification dataset (not shown). Likewise, the false alarm rate in the current study was higher than that computed in the rawinsonde study. This comparison suggests that the method of forming the ensemble needs further analysis and that the current configuration is probably not the best one to use. At this time, however, it is not clear whether problems exist with the algorithms, the numerical model, the method of arriving at the consensus forecast, or a combination of these factors. These issues will be addressed in year two.

Table 1 Verification Statistics for Algorithm Consensus Forecast using Eta output (FAR=false alarm rate, POD=probability of detection, Count=number of forecasts)

Precipitation Type	Projection	FAR	POD	Count
Rain	24-h	0.45	0.60	111904
	48-h	0.47	0.49	110693
Snow	24-h	0.19	0.36	128448
	48-h	0.27	0.28	130926
Ice Pellets	24-h	0.96	0.13	2986
	48-h	0.98	0.07	2744
Freezing Rain	24-h	0.78	0.36	10305
	48-h	0.84	0.24	10013

SECTION 2: SUMMARY OF RESEARCH AND EDUCATIONAL EXCHANGES

2.1 ***(To be completed by academic and forecaster partners)*** **Summarize other exchanges between your two organizations. These may include seminars or training workshops conducted by either the university or NWS/AFWA/Navy, participation of operational forecasters in university classes, joint preparation of publications, participation of students at the forecast office, etc. These do not have to be functions specifically funded by the COMET Outreach Program, but may include interactions undertaken in the spirit of improving relations between the academic and operational forecasting communities.**

Because of the nature of this project, the investigators at both organizations have had to maintain frequent communication throughout the project. The primary mechanism of communication has been through e-mail and telephone since the distance between Norman, Oklahoma, and Camp Springs, Maryland, precludes frequent face-to-face meetings. Since the investigators have tried to avoid excessive travel, one meeting was conducted through videoconferencing hardware available at the HPC and the SPC.

SECTION 3: PRESENTATIONS AND PUBLICATIONS

3.1 *(To be completed by academic partner and forecaster partners)* **Please provide complete citations using AMS bibliographic format for each thesis, dissertation, publication or presentation prepared as part of this project.**

In addition to the publication of the algorithm documentation on the project web page, there have been two presentations of the material provided by this project. The main university participant presented a brief description of the project to participants in the RFC-HPC Hydromet Course 01-1 in November 2000. The NCEP investigator made a

presentation on the precipitation-type algorithm ensemble approach to the NCEP-hosted SOO Workshop 14-17 November 2000 at the NOAA Science Center. Both presentations were well received by the participants.

SECTION 4: SUMMARY OF BENEFITS AND PROBLEMS ENCOUNTERED

4.1 *(To be completed by academic partner)* **Please list the benefits to the university resulting from the collaboration (new understanding of forecasting problems, exposure of students to operational forecasting, access to new observing systems, changes in course offerings, use of NWS/AFWA/Navy personnel as recourse, etc.). Identify any major problems encountered and describe their resolution.**

This project has provided several important benefits to the university. As a result of this COMET project, the university participants have been able to test and transfer research results into an operational setting more quickly than through other types of projects (e.g., NSF-sponsored projects). This project has provided financial resources for the university investigators to pursue an applied research project at a time when funding for applied research is scarce. The investigators also have gained a greater appreciation of time and information limitations within the operational forecasting environment. Most importantly, this project has given the investigators extremely valuable feedback from forecasters at two NWS national centers. The exposure to the operational environment and interaction with forecasters and research staff at these centers will ultimately help the investigators develop of an efficient forecast system for use in many types of operational and research settings. Without these valuable interactions with the NWS, the university investigators alone probably could not develop a system that works in an operational environment as efficiently as the current system does.

There was only one problem encountered by the university investigators in addition to a few minor problems with the web site (the web site problems were solved quickly). After implementing the procedure to run the algorithms and distribute the output, it was found that one algorithm required an excessive amount of CPU time to complete. This delayed the distribution of the data so much that it could not be used by HPC and SPC forecasters to create their products in a timely manner. Currently a new version of the algorithm is being tested that may reduce the processing time significantly. When the processing time has been decreased, it will be added to the consensus forecasts and used to create the risk assessment and most probable type products.

4.2 *(To be completed by forecaster partner)* **Please list the benefits to the NWS/AFWA/Navy office resulting thus far from the collaboration (promising new forecasting technique, heightened interest in research in the office, better understanding of new observing systems, potential new hires, use of university personnel as resource, etc.). Please be as specific as possible, particularly in regard to any improvements in forecasting operations resulting from this project (see examples). Identify any major problems encountered and describe their resolution.**

There have been several benefits of this experimental effort in the HPC and SPC operational arena. First, and foremost, the guidance products generated by the software have proven very useful in the preparation of the HPC 18, 30, and 54-hour projections of 12 and 24-hour probabilities of snow and/or ice accumulation exceeding regionally defined thresholds and the SPC Mesoscale Discussions related to hazardous winter weather, particularly freezing rain. Two qualities make this experimental guidance uniquely useful in operations: the hourly time resolution of the output and the multiplicity of the precipitation type decision components. A second important benefit is that this approach has broadened the forecasters' concept of ensemble forecasting, thereby stimulating interest in ensemble forecasting for the short range. A third benefit lies in the accessibility of the forecasters to the developers of the system. The best presentation methodologies for the guidance output have come directly from the forecasters themselves. This feedback with timely positive response has resulted in considerable forecaster enthusiasm for the guidance products in the HPC.

The problems have been remarkably few. Occasionally, the guidance product generation has failed, but the down time has been minimal. This reliability has helped to contribute to forecaster enthusiasm for the guidance tool. The only major problem has been procurement of data archival devices. A tape and disk drive order was placed but never received. After some tracking delays, the company agreed to refund the cost. A new order will be placed with a different supplier. In the meantime, a tape drive purchased for another project is being shared to off-load files archived on a disk drive also procured for another project.

SECTION 5: PLAN OF WORK FOR THE NEXT YEAR

5.1 *(To be completed by academic and forecaster partner)* **Describe what tasks remain from the original scope of work and the plan for accomplishing them. Please summarize the breakdown of work between the university participants and the operational forecasters.**

U - university participants, O - operational center participants

The remaining tasks to be accomplished in year two include (1) providing optimization of the melting model algorithm, which currently requires too much computing time (U & O), (2) producing an extensive evaluation of the forecast system's performance using data collected during the 2000-2001 winter (U & O), (3) determining if any additional modifications to the algorithms will improve their accuracy (U & O), (4) porting the entire system to the NCEP super computer (SP) and configuring it to run in closer connection with the operational model output (O), (5) incorporating all forecast system changes and having forecasters provide additional evaluations, with a focus on the use of the ensemble output (O), (6) analyzing forecaster evaluations from winter 2001-2002 (U), (7) working with EMC to submit a request to the NWS Committee on Analysis and Forecast Technique Implementation to include the precipitation-type algorithm output as part of the operational system at the NWS (U & O).

During the remaining twelve months of the project, tasks 1, 2, 3, and 4 will be completed by September 15, 2001. Tasks 5 and 6 will take place concurrently from October 2001 through January 2002 using a real-time verification system, modified from the system used in 2000-2001. In consultation with Geoff DiMego at EMC, preparation for task 7 will begin in February 2002. Although the investigators do not expect to perform all of the programming necessary to make this system part of the NWS operational product suite, they will work with EMC to help with the implementation process. *Additional funding may be requested at the end of year two if the NWS requests significant assistance with making the system operational.*

SECTION 6: FUNDING REQUEST

6.1 *(To be completed by forecaster and forecaster partners)* **If your budget for the next year is different from what was originally proposed, please attach a revised budget form.**

The budget for next year is not different from what was originally proposed.